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ADVANCEMENT OF THE DAIRY INDUSTRY

IN THE

UNITED STATES.

An Essay in competition

for the

BARLOW PRIZE

by

Allen Andrews. pseud. of
Borland
4424

PENNSYLVANIA STATE COLLEGE, 1909.

Advancement of the Dairy Industry in the United States.

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THE ADVANCEMENT OF THE DAIRY INDUSTRY IN THE UNITED STATES.

All through the centuries men have given thought and effort to dairying but the past century has witnessed the greatest progress in the dairy business because men have given it the best thought. Indeed it is little less than startling when we consider that formerly in the manufacture of dairy products the cows were kept in an unclean stable, were never curried and were usually covered with a thick coat of manure on their sides and flanks. The milking was done whenever convenient and with little regard for cleanliness, the milk dumped into cans without straining or, if strained at all, only through a wire strainer. This milk was then taken to the train and shipped to the city to some milk dealer. It was then sold from a can, placed on the seat of the wagon beside the driver, and measured in vessels that were coated with a film of dust from the city streets each time the wagon passed from one customer to the next. If the milk was intended for butter production it was placed in pans or crocks, the cream separated by gravity and kept four or five days to ripen, or longer if not enough had accumulated for a churning. The churning and working were done by hand and the product with its accumulated load of putrefactive bacteria was packed in tubs and marketed twice a year. It was usual for half the butter in market to be strong if not actually rancid. With dairy products low in quality, the prices were correspondingly low.

At the present time, while there is still a tendency in certain localities for the foregoing conditions to obtain, yet thanks to the

Milking in the good old times.

The modern method of milking.

activities of national and state dairy commissioners, pure food commissioners and dairy inspectors, as well as to an educated and enlightened public opinion, unsanitary conditions are rapidly being suppressed. In the modern sanitary dairy plant we find not only the cows but also the stable kept scrupulously clean, the cows milked by the mechanical milking machine, the cream separated from the milk by the centrifugal separator and at once cooled and aerated. The germs are then killed by pasteurization and the cream ripened with pure cultures of bacteria. A churn is employed which also works the butter before it is removed. To complete this triumph of modern skill the butter is printed, wrapped and put out by machinery without ever at any stage of the process having once come in contact with human hands. If the milk is intended for market it is immediately aerated in a glass room, cooled to forty-five degrees, filled into sterilized bottles, which are capped, counted and sealed by machinery ready for delivery to the customer.

A brief history of this onward march of progress may prove of interest to the reader.

EARLY HISTORY OF DAIRYING IN THE UNITED STATES.

Dairy cattle were first brought to Virginia in 1611 and to Plymouth, from the coast of Devonshire, in 1624. Later importations were brought to New York from Holland, to Delaware from Sweeden and to New Hampshire from Denmark. These various breeds were crossed and thus formed the original stock of the country. The cattle along the Atlantic coast fared miserably in winter. They had little or no protection and were fed upon swale and salt grass cut from marshes. It was a common opinion in the Virginia colony that the housing

The Surroundings 50 years ago.

The vicinity of the 20th Century barn.

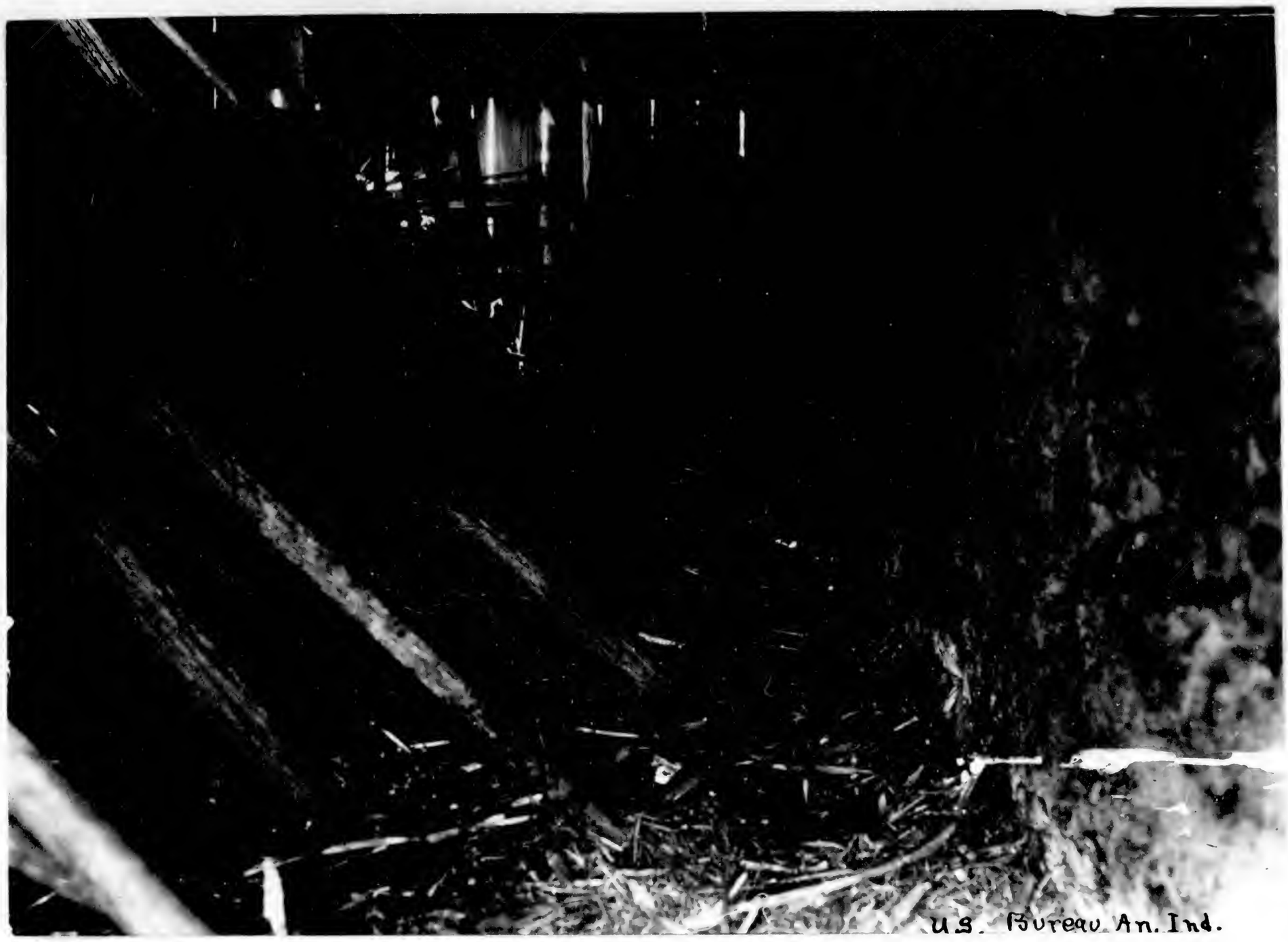
and milking of cows in winter would result in their death. A small amount of butter and cheese was exported from the colonies but dairying as a specialty did not make its appearance until well along in the nineteenth century.

In the early part of the nineteenth century the methods and utensils used in dairying were both crude and the milch cows were of nondescript breeding. Winter dairying was unknown. The cows usually calved in the spring, going dry in the fall or early winter and often, through lack of attention, dying of starvation or exposure.

In some sections the milk was set in shallow pans or earthon vessels for the cream to rise. Little attention was given to cooling the air in which the milk stood in summer time or to warming it in winter so long as the milk did not freeze solid. In other sections the entire milk was churned. This is still done in southern states to some extent. The general farm practice was to pack the butter in firkins or tubs and to let the cheese accumulate on the farm for at least six months. Marketing took place only once or twice a year. Much of the butter was rancid and the cheese sharp and both brought low prices.

DAIRYING DURING THE MIDDLE OF THE NINETEENTH CENTURY.

Until the middle of the nineteenth century dairying was a specialty in but few sections. In Herkimer County, New York, the making of cheese was begun about 1810. It was at first produced in limited quanities, the farmers fearing over-production. The industry gradually developed, however, and by 1830 had become quite general in Herkimer and adjoining counties in New York.



U.S. Bureau An. Ind.

Interior of the old-fashioned stable.

U.S. Bureau An. Ind.

Interior of the new-fashioned stable.

All the operations of the dairy continued rude and undeveloped. The cows were milked in the open yard and the curds were made in home-made tubs and pressed in log presses. Everything was done by guess; there was no order, no system, no science in dairy operations. With the inception of cheese and butter exportation, the dairy industry spread rapidly in the New England states and over New York, Ohio,and Pennsylvania, until by the middle of the century the exports of cheese averaged about 10,000,000 pounds annually.

DAIRYING DURING THE THIRD QUARTER OF THE CENTURY.

The rapid growth of cities during the third quarter of the nineteenth century and the development of transportation facilities, exerted considerable influence in the progress of dairying, increasing the demand for the products of the dairy and enabling the farmer to market them at a profit. This fact induced many to engage in dairying as a speciality instead of conducting the dairy as an accessory to general farming. Live stock shows became popular and attention was directed toward the improvement of farm animals. Breeds of cattle noted especially for dairy qualities were introduced and gained favor with dairymen. Co-operative dairying was recognized as successful and the cheese factory system became thoroughly established in New York. The foreign demand for cheese increased and the yearly exports rose from 10,000,000 pounds in 1850 to 15,000,000 pounds in 1860 and 50,000,000 in 1865. Ten years later over 100,000,000 pounds were exported.

Establishment of Cheese and Butter Factories.

Associated dairying began with the establishment of a cheese

factory by Jesse Williams, of Oneida County, New York, in 1851. Mr. Williams was an experienced cheese maker and received such a good price for his product that he increased the output by adding to his own supply of milk that of several sons located on farms nearby, and then that of his neighbors. From this beginning the number of cheese factories increased slowly at first, but afterward more rapidly until in 1870 there were 1,313 cheese factories in operation. From 1870 forward the factory system of making cheese practically superceded the making of cheese on farms. According to the census of 1900 there were in the United States, 3,585 cheese factories which manufactured 281,972,324 pounds of cheese, or 94.5% of the total amount produced in the United States. The making of butter from milk or cream collected from a number of farms soon followed the establishment of cheese factories. So far as known the creamery system of butter-making originated in the United States. The first creamery was built by Alanson Slaughter, near Wallkill, Orange County, New York, in 1861, and received daily the milk from 375 cows. At the present time the factory system is gaining rapidly in favor and by the census of 1900 the 5,567 creameries manufactured 420,954,016 pounds of butter or 28.2% of the total amount produced in the United States. It is interesting to note that during the decade of 1890-1900 the percentage of butter manufactured in creameries increased from 18.2% of the whole amount produced in the United States to 28.2%.

The Associated System of Dairying.

The associated system of dairying constitutes one of the notable landmarks in the progress of dairying during the past century. The early cheese factories and creameries were purely co-operative

and it is in this form that the system has been generally extended into new territory whether in the form of cheese or butter factories.

There are, however, various other forms of ownership involving the co-operative principle in part or else being purely proprietary.

When the first cheese factories and creameries were established, the milk of several patrons was drawn to the factory and placed in large vats for cheese-making, or set in deep cans surrounded by running water for butter-making. The cream was separated from the milk by gravity and afterward skimmed and churned. After a time the gathered cream system was introduced. Under this system the cream was separated on the farm, usually by a cold, deep setting process, and a representative of the creamery visited the farm, skimmed the cream and left the skimmed milk on the farm. Later, during the decade beginning with 1880, the centrifugal separator was introduced and at the present time by far the larger number of butter factories are operated upon this system.

The earliest factories and creameries paid for milk and cream by the quart or gallon, equal bulks being regarded as equal in value. The next step in advance was to purchase the milk or cream by weight, equal weights being then regarded as equal in value. When the gathered cream system was introduced, equal bulks of cream were still regarded as of like value. The modern, as well as the most accurate method of purchasing is to pay for the amount of butter-fat the milk or cream contains. This is determined by mechanical methods to be described later.

At first it was considered sufficient to have 200 cows tribut-

ary to a creamery and the patrons located within a radius of two or three miles. Later larger factories were favored as more economical and the patrons hauled the milk to the creamery by a co-operative plan so that each patron made a trip to the creamery but once in seven to fourteen days. In the late form of creamery, each patron is expected to cool the milk thoroughly before shipping it to the centralized factory which receives the product from several thousands of cows, distributed over many square miles of territory.

The large quanity of cream still appearing as raw material at creameries is indicative of another improvement in dairying, viz. "Skimming Stations". It has been found that the labor and expense of daily hauling of the entire milk product to the creamery, often several miles distant, is too great a tax upon the industry. To meet this need and effect economy in creamery management these skimming stations have been established. They are equipped only with a separator and power to run it. The separated cream is transported from the station to the parent creamery, where it is manufactured into butter.

Improvements in Mechanical Appliances Used in the Dairy.

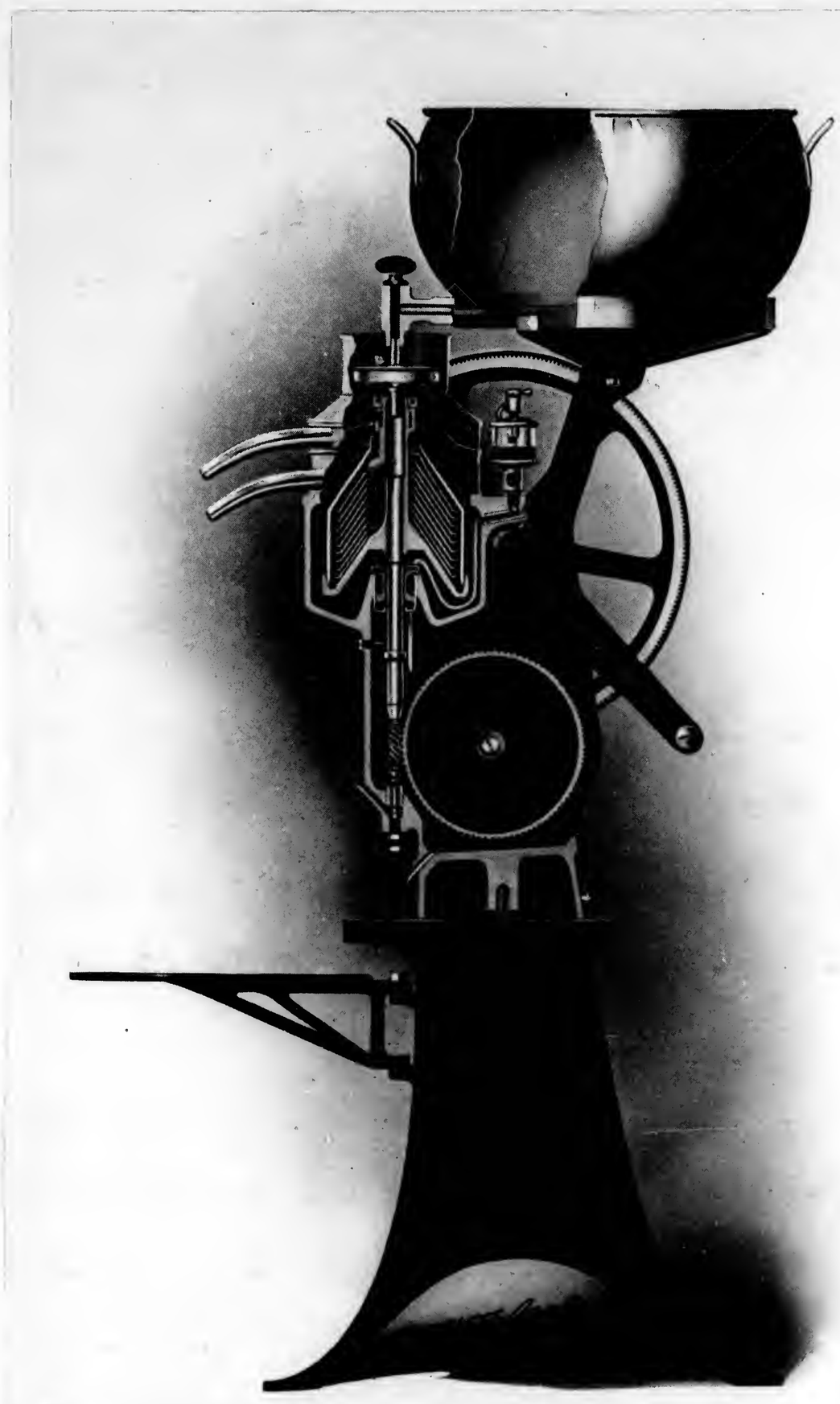
Startling progress has also been characteristic in the application of mechanics to the dairy. The growth of factories and creameries called for new equipment adapted to manufacturing upon an enlarged scale and equal attention has also been given to the invention of appliances for the improvement of the farm dairy. Among the many improved appliances may be mentioned the centrifugal separator for separating cream from skim milk, the Babcock test for ascertaining the amount of butter-fat in milk or cream, the combined churn

and worker, the pasteurizer for killing germ life, the multiple bottle washer, the milk cooler and aerator and the mechanical milking machine.

CENTRIFUGAL SEPARATORS. From time immemorable cream has been separated from milk by making use of the principle that the specific gravity of milk serum is greater than that of the globules of fat, which,with such particles of water and solids as adhere to them, compose the cream.

The importance of the application of centrifugal force to the separation of cream cannot be over-estimated. In fact, the invention, development and perfection of the centrifugal separator has been the chief factor in revolutionizing methods of butter-making. The cream can be churned at once while still sweet, if so desired and the skim milk is available for use while still warm, sweet, and in good condition for feeding young animals. This method is more efficient than the gravity system and secures better separation with less loss of fat in the skim milk, the percentage of fat in the skim milk being but .02 to .05%.

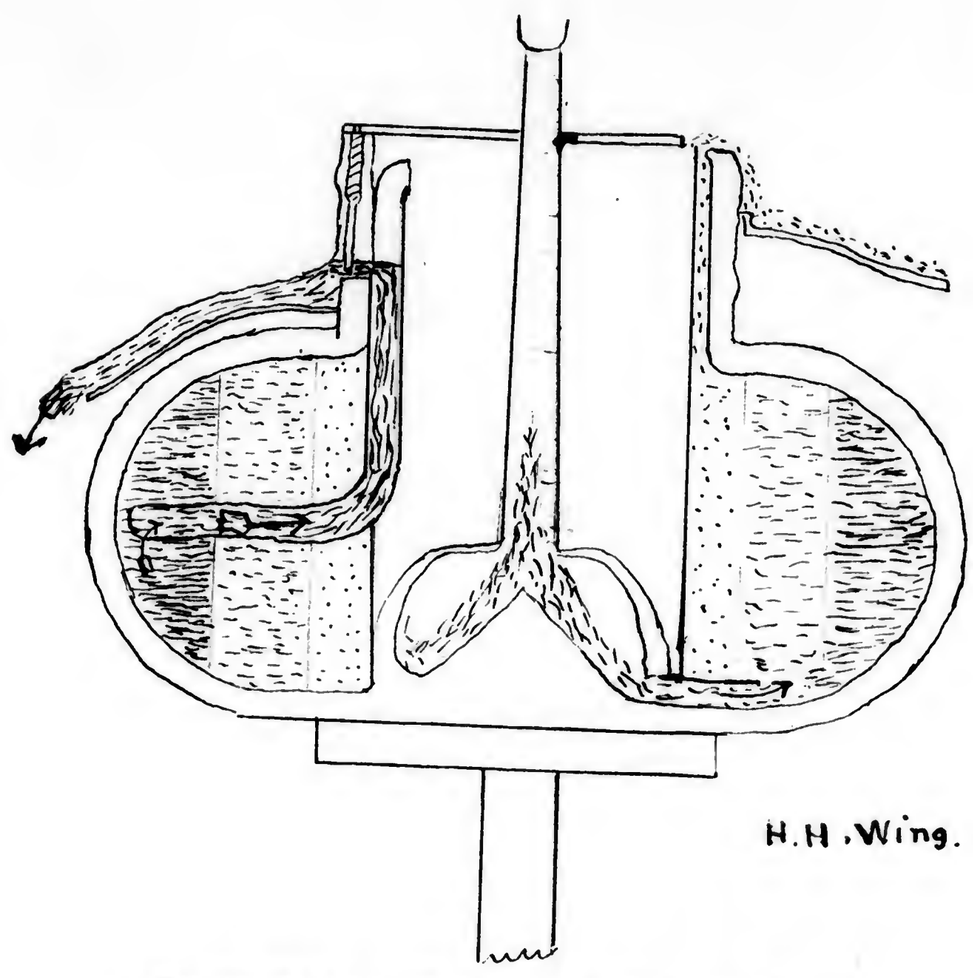
In separating cream from milk by centrifugal force, the centrifugal force in a rapidly revolving bowl is made to take the place of gravity acting on milk at rest in a vessel, only the centrifugal force is so much greater than the force of gravity that the cream is separated much more quickly and thoroughly. In 1877 a patent was granted LaFeldt and Lentsch for a machine to separate milk by centrifugal force. This machine simply had a series of buckets hung on horizontal arms swinging from a central axis. When the cream was separated from the milk the machine was stopped, the cream skimmed off in the ordinary way and the buckets refilled with milk. From this it



Vertical section of a modern separator.

was but a step to the revolving bowl in which the separation took place with arrangements for continuous inflow of milk and outflow of skim milk and cream.

In the process of separation the milk flows into the rapidly revolving bowl and is there acted upon by the centrifugal force which throws the part of the milk having the greatest specific gravity to the outside and forces the lighter particles of fat to the



Section of separator bowl.

inside. Near the outer portion of the bowl are one or more tubes leading inward along the side of the bowl and opening near the center. These are the skim milk outlets. Another tube located at the extreme center of the bowl delivers the cream to the outside. When the bowl becomes filled with milk the centrifugal press will force the milk nearest the outside through the skim milk outlets. These outlets are made of such a size that, when taken in connection with the size of the bowl, the speed of the machine and the size of the inflow tube, they discharge from .4 to .9 of the amount of milk entering the bowl; the remaining contents are then forced toward the center of the bowl where they find an exit through the cream outlet. In this way the milk as it enters the bowl is divided into two portions; the larger, drawn from the outside of the bowl consisting of skim milk and the smaller, escaping

from the center of the bowl, the cream.

The number of centrifugal separators in use by creameries was first reported for the twelvth census. There were returned 9,701 separators in use by butter factories. As to the number of hand separators, there are no statistics for the whole United States. In the state of Iowa alone, however, the state dairy commissioner reported 904 farm separators owned by patrons of creameries in 1898; 1762 in 1899; 3332 in 1900; 5231 in 1901; 8323 in 1902 and 16,800 in 1903. This being the report from but a single state it is apparent at a glance what a revolution in dairy methods the centrifugal separator has wrought and how by its greater economy of labor it has rendered possible the development of a profitable industry in many localities where it would otherwise have been impossible.

FAT TEST FOR MILK. Another potent factor in the development of the dairy industry is the popular fat test for milk. When one stops to think that less than twenty years ago the best means a buttermaker had for ascertaining the quality of milk was a crude test tube where the milk was set for the cream to rise, and a lactometer which would indicate that milk was good after it had been both watered and skimmed, he can realize what great progress has been made in milk testing during the last few years.

Up to the year 1888 there had been no apparatus devised that would determine the fat in milk quickly, accurately and cheaply. The same year marked the establishment of the National Grant to Agricultural Experiment Stations and during the next two years no less than seven distinct methods were devised by chemists of Experiment Stations for this purpose. All of them were much better

than any that had hitherto been known, but one was so much in advance of the rest that it is now practically the only method used for the quick determination of fat in milk. This is the method devised by Dr. S. M. Babcock, of the Wisconsin Experiment Station, known as "The Babcock Test" and first published in July 1890. This machine combines the principles of centrifugal force with simple chemical action. To destroy the solids other than fat a single reagent, sulphuric acid (sp. gr. 1.82) is used and the fat is then separated from the remaining contents of the test bottle by centrifugal force, hot water being added to bring the contents of the bottle up into the narrow graduated neck from which the percentage of fat may be read directly. By the use of these machines from two to forty samples may be tested at once, in a few minutes and by the use of bottles specially provided the percentage of fat may be determined in samples of butter, cheese, milk, cream, skim milk, whey and buttermilk. The fat test of milk has a wide application. It may fix the basis for municipal milk inspection, regulate the price of milk and cream for city trade and,at creameries, cheese factories and condens-ories. In the hands of a competent dairyman (when yearly milk records are kept) it shows the value of different animals for dairy purposes and is often used in connection with the dairy scales to determine the selling or purchasing price of cows. With perfect apparatus and a competent person in charge of the work, the accuracy of the test is beyond question and its use is of the highest scientific and economic importance.

COMBINED CHURNS. The ancients churned their milk without separating in bags made from skins of animals. The next step in

advance was to place the milk and cream in bottles or jars and then to shake them. At a later date butter was made on a large scale by churning the cream in a large box or barrel run by power or by hand. The churns used in American butter factories at the present date are termed "Combined Churns". They are so arranged as to admit of churning, washing, salting and working the butter without removing it from the churn. Owing to their superior worth they are now in general use in Europe, as well as in the United States. Some of their advantages are as follows;- They keep flies away from the butter in summer time; the temperature of the butter can be controlled in the churn and the necessity for handling the butter during the salting and working is obviated.

BOTTLE WASHERS. The recent invention of the large multiple milk bottle washer is worthy of notice. It is made by a number of different firms. Crates,containing twelve bottles each, are turned upside down and entered on an endless apron at one end of the machine. Revolving brushes, hot water and steam are shot up into the bottles at different steps in their progress through the machine. When the crate emerges from the other end of the machine the bottles have been washed, rinsed and sterilized. By this method several thousand bottles per hour are cleansed.

BOTTLE FILLERS AND CAPPERS. The combined bottle filler and capper is another mechanical improvement that has come into use during recent years. A crate containing twelve bottles is placed in position on the platform of the filler and all the bottles filled at once without overflow or foam by simply pulling a lever.

COMBINED MILK COOLERS AND AERATORS. In the early history of the dairy industry in the United States milk was never aerated and but slowly cooled by placing it in vessels surrounded by water. Investigators found that offensive odors were considerably lessened by exposing the milk in pure air so that gases and unpleasant odors might pass off. It has also been demonstrated that milk must be cooled at once when drawn from the cow in order to maintain its keeping qualities. To-day we have the combined aerator and cooler. The milk flows down over a corrugated surface or series of pipes inside of which a stream of cold water or brine passes to keep the surfaces constantly cool. In this way the milk is at once cooled and aerated and the quality accordingly improved.

PASTEURIZERS. More than one million babies in this country depend on the cow for their only food. The frightful mortality among infants fed on cows milk in the cities during the last few years has led to the wide-spread adoption of pasteurization, a process which consists in heating the milk to a temperature of 140 F to 212 F. This kills practically all the germs in a vegetative stage. Since most of them are in a vegetative condition, the process kills almost all the organisms. The heating is followed by rapid cooling. The word itself comes from Pasteur a French scientist, who devised the method for treating wines and thus preventing them from various undesirable fermentations. Owing to its own merits pasteurization has also gained favor with American creamery operators. It has been thoroughly demonstrated that if the operator is to produce the best results, he must have

Milk before pasteurisation.

Milk after pasteurisation.

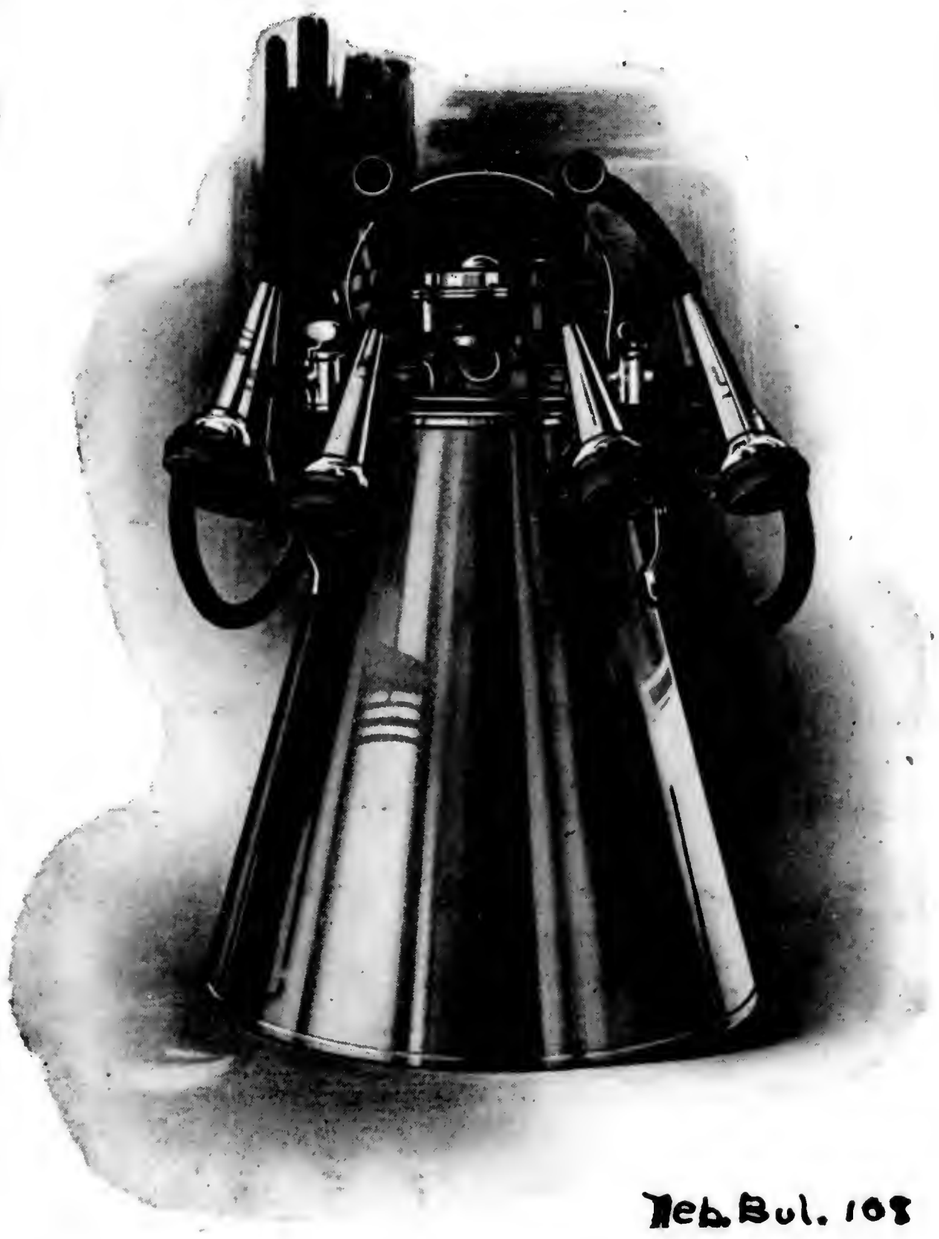
thorough control of fermentation in the cream or milk, a condition easily secured by pasteurization. The Danish Government has compelled the pasteurization of milk and cream as a safe guard against tuberculosis. It was found not only that the process was efficient in this respect, but also that it produced a more uniform product with better keeping qualities. Various pasteurizing machines are in use, the common features of all being facilities for heating and cooling the milk and cream.

The process enables the buttermaker to produce a uniform quality of butter; eliminates undesirable taints in milk; destroys most of the germs; aids the buttermaker in controlling the fermentation in cream; increases the keeping quality of butter, and enables the operator to do closer skimming than when milk is separated at a low temperature. Pasteurization is well entitled to an important rank among the useful mechanical appliances of the dairy industry.

MILKING MACHINES. Owing to the great progress that has been made in the dairy industry during the last few years, there has come to be such a great demand for men to help with the milking that dairymen are unable to secure them at a compensation that will allow a fair margin of profit. The confinement and nature of the work frequently make the milkers discontented and cause them to seek more pleasant work elsewhere. Face to face with this condition many dairymen have reached the point where they must either discontinue the dairy business or else secure a mechanical apparatus that will do the milking. The invention of a milking machine,which is being operated successfully by many large dairy farmers,comes as a solution of the foregoing and of many other dairy problems and promises

to still further revolutionize dairying as a business by placing it on a larger and more profitable basis.

Inventors have been working for years to produce a milking machine and while some of these machines have been working for several years with a certain degree of success, yet it is but recently since the true principle of imitating the action of the calf's mouth on the teat was discovered. In other words, suction was produced at intervals. These intervals are known as pulsations and have been reproduced in the machine, a fact which has aided materially in bringing about its present success.



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The machine consists of rubber tubes ending in special cups for attachment to the teats of the cow and connected at the other end with large cans which may be sterilized. The cans are connect-

ed with a vacuum system of tubes and at the point where the rubber tubes are attached to the can there is a mechanical device by which the vacuum is made to draw through the tubes intermittently. Suction is applied to all four teats at once and as air is drawn from the teat cups the milk is forced out to fill up this space. It is thence drawn into the empty can. The inspection glasses on the lid of the milker enable the operator to see the milk as it passes into the pail and to determine when the cow is milked dry.

Organization of Dairymens Associations.

The organization of dairymens associations has been an onward step in the progress of dairying. The American Dairymans Association was formed in 1863. Since its field of action was almost entirely in the eastern states, the Northwestern Dairymans Association in 1867. Both were active in forwarding dairy interests. Then in decade 1870-80 followed the formation of State dairy associations in Vermont, Pennsylvania, Wisconsin, Illinois, Iowa, New York and later in the remainder of the states At the present time besides the State dairy associations in the different states, there are no less than eight National and International associations actively engaged in promoting the interests of the dairy business.

Improvement in Dairy Cattle.

The progress made in this respect during the last fifty years has been remarkable. At that time a cow that would produce a pound of butter a day, for two or three months, was considered a wonder.

Occasionally a single animal would be found that was really worthy of note. The famous Oakes cow in Massachusetts, about 1816, averaged forty-four pounds milk per day and made 467 pounds butter during one season but she failed to reproduce her equal. The first authentic record of definite herd improvement was made by Zadock Pratt of Greene County, New York. By careful selection he increased the average butter product of his fifty cows from 130 pounds in 1852,to 225 pounds in 1863, the average milk yield per year being 4,710 pounds. The good dairy cow has been so long bred for a special purpose that instead of milking for a short time during the pasture season, she now produces milk for eleven months out of the year and many individuals keep up the flow of milk for the entire year. A cow that does not average seven quarts of milk per day for three hundred days, being 4,500 pounds per year, is not considered profitable. Many herds average considerably over 5,000 pounds of milk per year and numerous individuals give from twelve to fifteen times their own weight of milk per year. Quality also has been so improved that the milk of one cow will make as much butter per week as that of three or four cows during the middle part of the past century. Many herds average from 300 to 350 pounds per year and single individuals much higher. Colantha 4th's Johanna has an official yearly test of the enormous total of 27,432.5 pounds of milk,averaging 3.64 percent of fat, or 998.26 pounds of butter-fat, equivalent to 1165 pounds commercial butter. This is an average of over three pounds per day for the entire year. Perhaps the most striking evidence of the improvement of dairy cattle in a single decade is found in a comparison of the figures of the eleventh and the twelvth census. By the former the average annual milk product per cow was 315.4 gallons; by the latter it had increased to 424 gallons per cow. Even if we were to allow

fifty gallons per cow for possible errors in returns there would still be a remarkable gain. Hence there can be little doubt of the material improvement in the productiveness of dairy cattle within the last few years.

DAIRYING AT THE PRESENT TIME.

The twentieth century finds the dairy industry occupying the highest plane in its history. The crude and inconvenient methods of a generation ago have given away to a system based upon knowledge and skill, and the application of modern labor-saving machinery. In many localities the co-operative, or factory system, has almost entirely supplanted the home manufacture of dairy products. Skimming stations, located at convenient points are dotted all over the dairy districts. To these stations the milk from the farms in the neighborhood is taken for separation and thence the cream is shipped to the central factory for manufacture. Here in one room several tons of butter are made every day and sold on its reputation by orders received in advance. Owing to the uniformity and excellent quality of the product it finds a ready sale at a good price.

Educational Progress.

The facilities for acquiring knowledge of the dairy industry and for fitting ones self to hold positions of honor and trust, positions that call for education and skill, have kept pace with the general progress in the dairy world. Besides local clubs and unions, there are in almost every state of the Union dairy associations which hold annual conventions and publish reports of

their proceedings, including addresses on different phases of the industry by men who are specialists in their respective lines. Large competitive exhibits of dairy cattle, products, and machinery are also held,- notably the International Dairy Show held yearly at Chicago, and including exhibits pertaining to every conceivable phase of the dairy industry. Several states provide by law for officials known as "dairy and food commissioners". The United States Department of Agriculture maintains a Dairy Division whose duty it is to seek out information that will be conducive to the improvement of dairying and to keep the people informed on matters of general dairy interest. A number of states maintain dairy schools, offering courses which give a thorough, practical and scientific education in all the different branches of dairy work. These schools, with the agricultural experiment stations, are doing much original research work and adding to the store of useful information in regard to applying scientific principles to the dairy industry. These results are published in the form of bulletins and are sent free to the citizens of the various states. Graduates of these schools are scattered far and near over the country and are doing their share toward the general improvement and increased knowledge of dairy methods. Numerous dairy journals and periodicals are being published and a number of noteworthy books have recently been written so that everyone who desires may become well informed on every phase of the dairy industry.

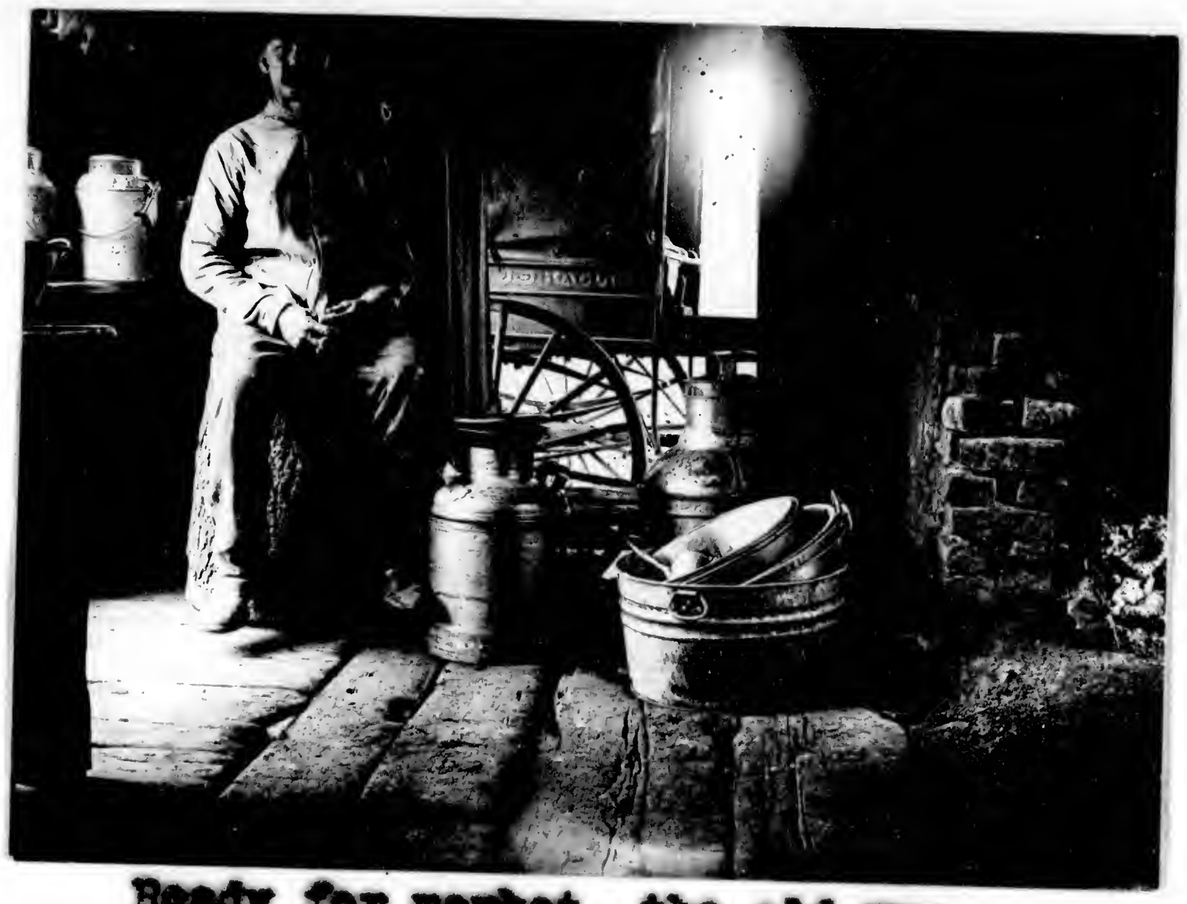
Milk Production.

The business of supplying milk for town and city consumption has grown to immense proportions.

Municipal regulations have done much to raise the standard of the milk supply, but even more has been done through private enterprise. Competition among smaller and larger establishments for the reputation of supplying clean, wholesome milk, produced from healthy cows, kept under sanitary conditions, has led to a higher standard than has all the legal requirements.

CERTIFIED MILK. A model farm, where care, cleanliness and sanitary conditions are observed, cannot compete with a filthy farm in the production of milk, if that from the latter sells for a price equal to that of the former. It was in appreciation of this principle that the so-called "Certified Milk" came into existence about ten years ago. Milk commissions were organized which made regular examination of the animals, their feed, attendants and the product, and certified to the consuming public whether the conditions prescribed as necessary for certification had been observed by the producer. Such milk sells at a considerable advance over the market price and has been the essential factor in lowering the infant mortality in large cities.

CONDENSED MILK. Attempts to convert milk into a condition in which its valuable properties may remain unchanged for a long time date back to the early part of the nineteenth century. These attempts all proved to be failures up to 1856, when Mr. Gail Borden of New York, obtained results that have since popularized the pro-



Ready for market, the old way.

Ready for market, the new way.

duct in every part of the world. The condensed milk was prepared in a semi-liquid form by the use of a vacuum pan for evaporating the water. No sugar was added or any other foreign substance and the product was packed in open cans. This product fulfilled all the requirements if not kept too long. To increase the keeping qualities Gail Borden then tried condensed milk with the addition of sugar and packed the product in air-tight, soldered, cylindrical, metal tins. This method solved the problem in a satisfactory manner and gave a preserved milk that was pure, wholesome, palatable and capable of being transported long distances, and kept under trying climatic conditions.

To show how the industry has grown we append the following statistics*;-

Year	Product	Value
1880	13,033,267 lbs.	$1,547,588
1890	37,926,821 "	3,586,927
1900	186,921,787 "	11,888,792

MODIFIED MILK. To meet the demand for a milk having a definite composition to be used largely in infant feeding, the last few years has brought us the "Modified Milk". This is milk that has been so blended as to conform to a definite standard of composition. It is prepared only in special laboratories and is sold largely on the prescription of a physician.

MILK POWDER. The closing year of the nineteenth century witnessed the invention of a successful method for the production of milk powder, which is the dry solids of milk in the form of a powder. The first patent taken out for the production of dry milk

*Bureau An. Ind., No. 55, pg 40.

The milk house of our forefathers.

Sanitary milk house of the present day.

was in 1835, by a Mr. Newton. Other patents were recorded from time to time but there is no record of the processes in them being a commercial success until 1899-1900. Since the latter date several factories in New York and New Jersey have been producing considerable quanities of powdered milk by various processes. Milk powder is particularly adapted for use in baking, for which it may be used either by mixing directly with flour or by reconstituting it by addition of water and then used as ordinary milk. It is also used in the preparation of many kinds of confectionery. It has many advantages over ordinary milk in regard to transportation and economy of storage. *"The manufacture of powdered milk will undoubtedly have an important bearing on the whole dairy industry, making possible the transportation of fresh, sweet milk from places heretofore inaccessible because of distance."

Cheese Making.

The cheese making industry at the present time is almost wholly carried on by the factory system. So little farm cheese is made that it does not affect the market at all. A change that seems to be taking place in the factory system is the bringing of several independent factories under one management. This tends to secure greater uniformity of product, increase the quality and lessen the cost of manufacture. The total production of cheese on farms for the last census year was 16,372,330 pounds, and in factories (of all kinds) 282,634,488 pounds, or an aggregate of 299,006,818 pounds. This was an increase of 16% over the total amount reported in 1890.

*Bailey's Enclyp. Agr. Vol. 3, pg 195.

Butter Making.

At the present time creamery butter controls all the large markets, dairy butter making comparatively little impression on the trade, but home consumption and the supply of local markets and private customers make an immense aggregate,-almost two-thirds of the total output of butter. The average quality of American butter has greatly increased since the introduction of the creamery and the application of modern appliances and sanitary methods. In many localities there is still room for improvement. No butter is imported into America and, as yet,little is exported. The twelvth census reports 1,071,745,127 pounds of butter made on farms, and 420,954,016 pounds in creameries, or an aggregate of 1,492,699,143 pounds. The census authorities estimate that in addition more than 50,000,000 pounds were actually made which escaped the returns. If approximately correct, this would be at the yearly rate of about twenty pounds per person or 100 pounds annually to the family of average size.

STARTERS. One of the important advancements in the butter-making industry is the use of starters. The introduction of pure cultures, or commercial starters, dates back to 1890, when Professor Storch,of Denmark, recommended their use in creameries. Starters were used in that country for a time successfully and since then have been introduced and used extensively in this country as well as in practically all European countries. Experiments have proved that certain species of bacteria are chiefly concerned in the production of flavors developed in cream while ripening. This fact has given rise to the preparation of pure cultures to be introduced into the cream for the purpose of developing the desired flavor. These pure cultures

contain, in a virulent condition, the germs which produce the desirable flavors. In the preparation of pure cultures the germs are isolated and inoculated into a medium suitable for their growth. They are then put up and shipped to creamerymen by laboratories especially provided for this kind of work. To the use of these starters may be attributed no small share of the improved quality in American butter of to-day.

MOISTURE TESTS, CASEIN TESTS AND SALT TESTS. The commercial value to those engaged in the creamery business of knowing the moisture content of butter has created a demand for a simple and accurate method of ascertaining the percentage of water in butter. The recent enforcement of stringent pure food laws has emphasized its need to dealers. To meet this demand a number of successful methods have recently been devised and put upon the market. Perhaps the most accurate of these are the "Grey's" and the "Ame's" method. By the former the moisture is driven off by heat and condensed in specially prepared distilling apparatus which is graduated to show the percent of moisture. By the latter a sample of butter is weighed out and the moisture then driven off and allowed to escape. The residue is then re-weighed and the percent of moisture calculated from the loss in weight.

It is to be noted that Casein tests operated on the principle of the Babcock tester have recently been invented, and also that simple, rapid and accurate methods of determining the salt content in butter are in use at the present day.

RENOVATED BUTTER. In recent years a large business has grown up in gathering together, usually from country stores which have

taken the goods in exchange, large quanities of poorly made butter, or that which has been partially spoiled. This rancid butter is all melted up together and the solid impurities filtered out. While still molten, air is blown through to remove the disagreeable odors and tastes. The molten fat is then churned with fresh skimmed milk, chilled to make it gramular, drained, washed, salted and worked in the usual way. In some cases the better grades of butter collected from country stores are merely reworked and uniformly colored. All such butter, whatever the treatment it has received, is known as "Renovated",or "Process" butter. While it is much improved over the original butter, it is still inferior to fresh butter, the sale of which it injures to a greater or less extent. For this reason several states have passed laws that all butter thus treated shall be distinctly marked "Renovated" Butter.

Ice Cream.

The evolution of ice cream making is an interesting feature of the dairy industry. In early times the cream mixture was placed in a small vessel which was twirled by hand within a larger, after ice had been placed between the two. Later the mechanical freezer was invented and the whirling was done by machinery. The next step in the improvement of the process was the use of the brine freezer instead of ice and salt,and at present we have the continuous freezer, which is fed by brine and cooled by artificial refrigeration. It receives a continuous supply of cream mixture at one end of the freezer and delivers at the other the frozen product at the rate of sixty to one hundred-and-fifty gallons,

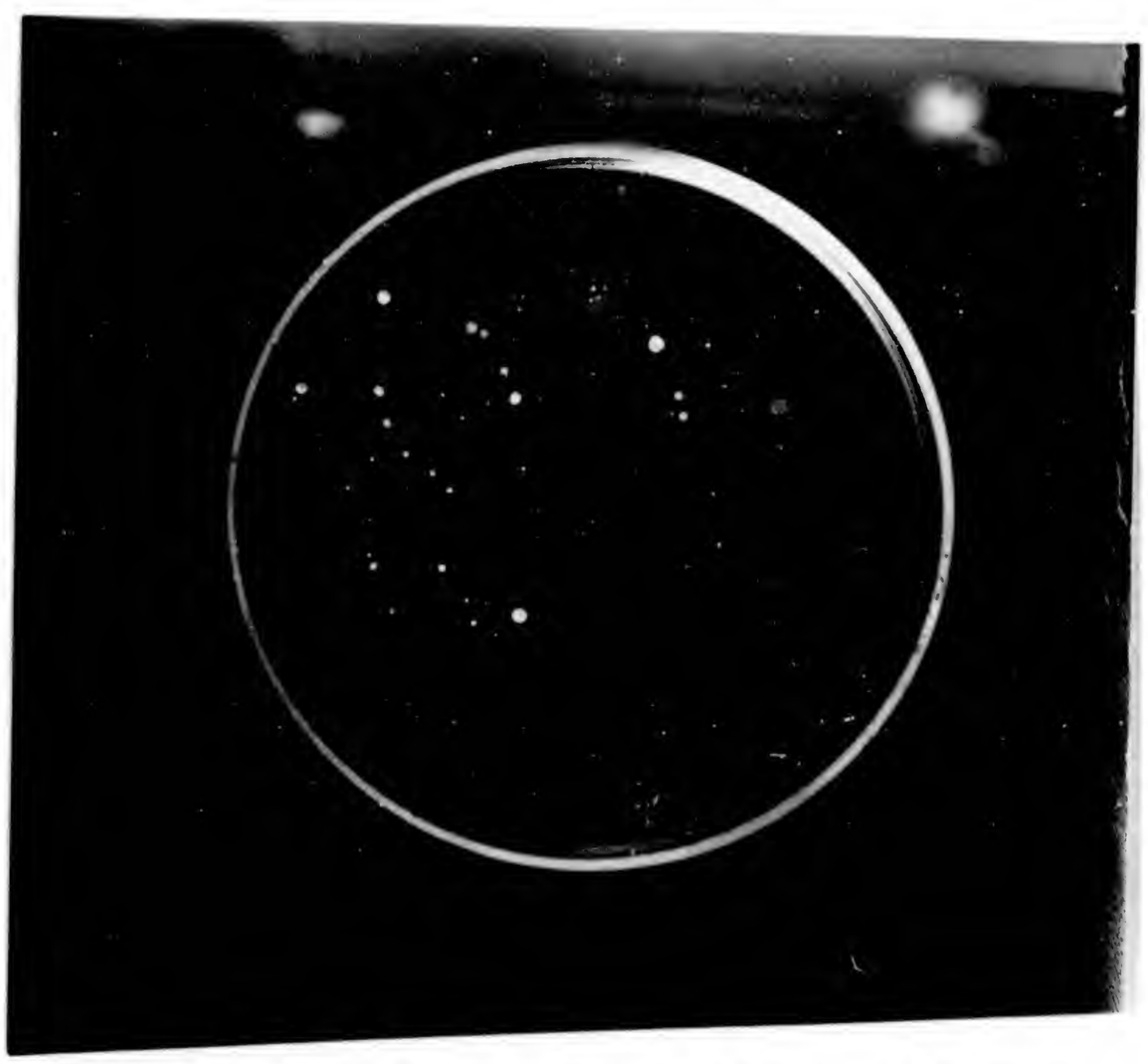
per hour.

Bacterial Investigations.

Much progress has been made in bacterial investigations in recent years. Bacteria are extremely minute organisms consisting of a single cell filled with protoplasm. They reproduce by division. In ordinary milk nearly all kinds of bacteria find an adequate and easily available supply of food. Consequently, nearly all forms of bacteria will readily live and grow should they gain access to milk. Investigations reveal the fact that in ordinary milk bacteria are always present in large numbers. They gain access to the milk from the atmosphere, from the bodies of the animals, and from the milkers, also, through contact with the vessels into which the milk is drawn, and to some extent, through the udder of the animal. Milk when secreted is sterile. So far as is known no bacteria can pass through the digestive organs and the blood vessels of the animal and appear in the milk, but if the udder is the seat of disease due to the growth of bacteria such bacteria may find their way into the milk ducts and infect the milk. By far the greater number of germs ordinarily found in milk are harmless, and,with the exception of the germs of certain specific diseases, may be taken into the human system in large numbers with perfect impunity.

The accumulated evidence of the last twenty years has shown that four specific diseases, together with a fifth type less definitely understood, may be distributed by milk. These specific diseases are,-tuberculosis, typhoid fever, scarlet fever, and diphtheria and the less definite type includes diarrhoeal troubles,

Bacterial colonies in milk cooled at once to 35°F and plated after several hours - 500 colonies per cc.



Bacterial colonies from same milking allowed to stand uncovered at 65°F and plated after several hours,- 5000 colonies per cc.

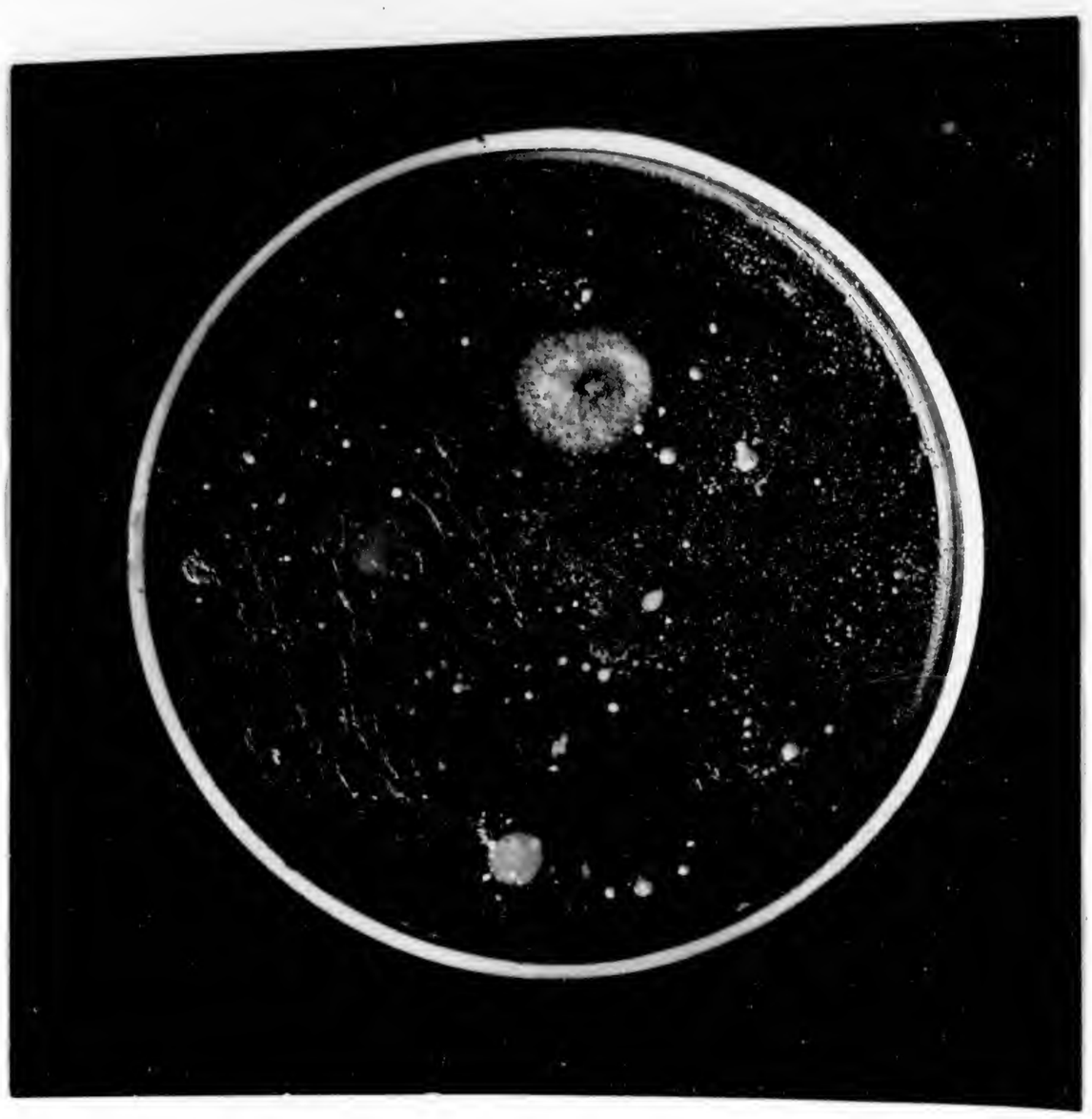
commonly known as, cholera infantum, summer complaint, etc. Experiments prove that the greatest source of bacterial infection comes from the body of the animal and from the air of the stable. Hence it is necessary that the animal be carefully curried and the udder, teats, side and flanks of the animal be wiped with a damp cloth before milking; that the hands and clothes of the milker receive careful attention and that the air of the stable be free from dust at milking time.

It has also been found that next to the stable the dairy utensils are important sources of bacterial infection. They become attached to the seams and corners of the vessel and are difficult to dislodge. After milk vessels have been washed, they should be exposed to the action of live steam for at least three minutes. By observing such precautions milk will easily keep from eighteen to twenty-four hours longer than that drawn under average conditions.

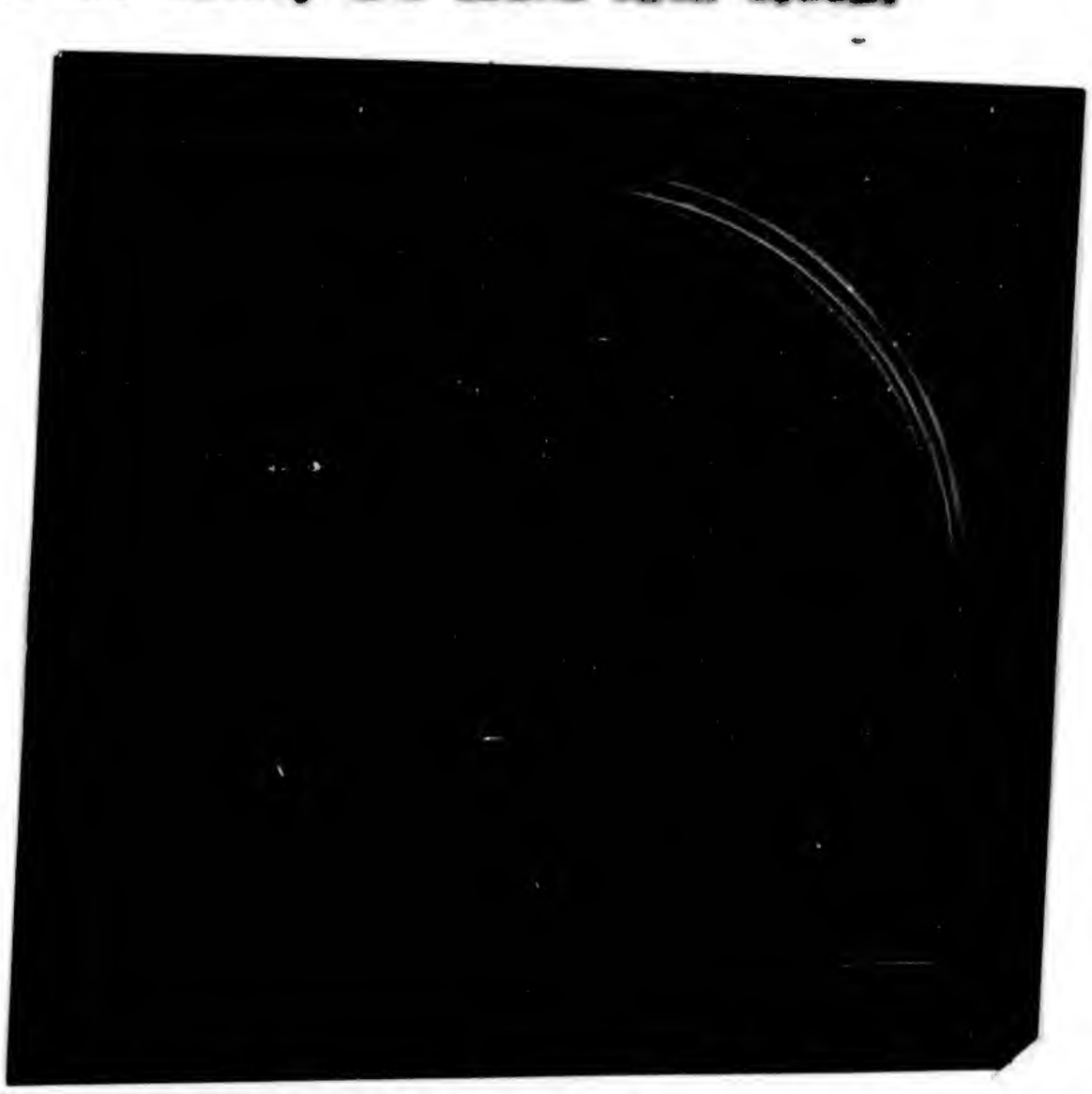
TUBERCULOSIS. The chief conclusions of recent years in regard to problems associated with tuberculosis are as follows;*

"It is thoroughly recognized that this disease is one of the most serious menaces to the dairy industry. It is known to be present and increasing in our dairy herds. It is known that in the more thickly settled parts of this country, as well as in Europe, the percentage of the disease is quite large, although it is difficult to give exact percentages. In cold climates where the cattle are housed much of the time, it is more common than in warm countries where they remain out of doors. In America it does not appear to be as common as in Europe; but still in the dairy districts of

*Conn's Dairy Bacterology, pg 87.



Contamination of milk from unclean bucket.
(a) Bucket washed with hot water and soap, rinsed with clean hot water, and dried with towel.



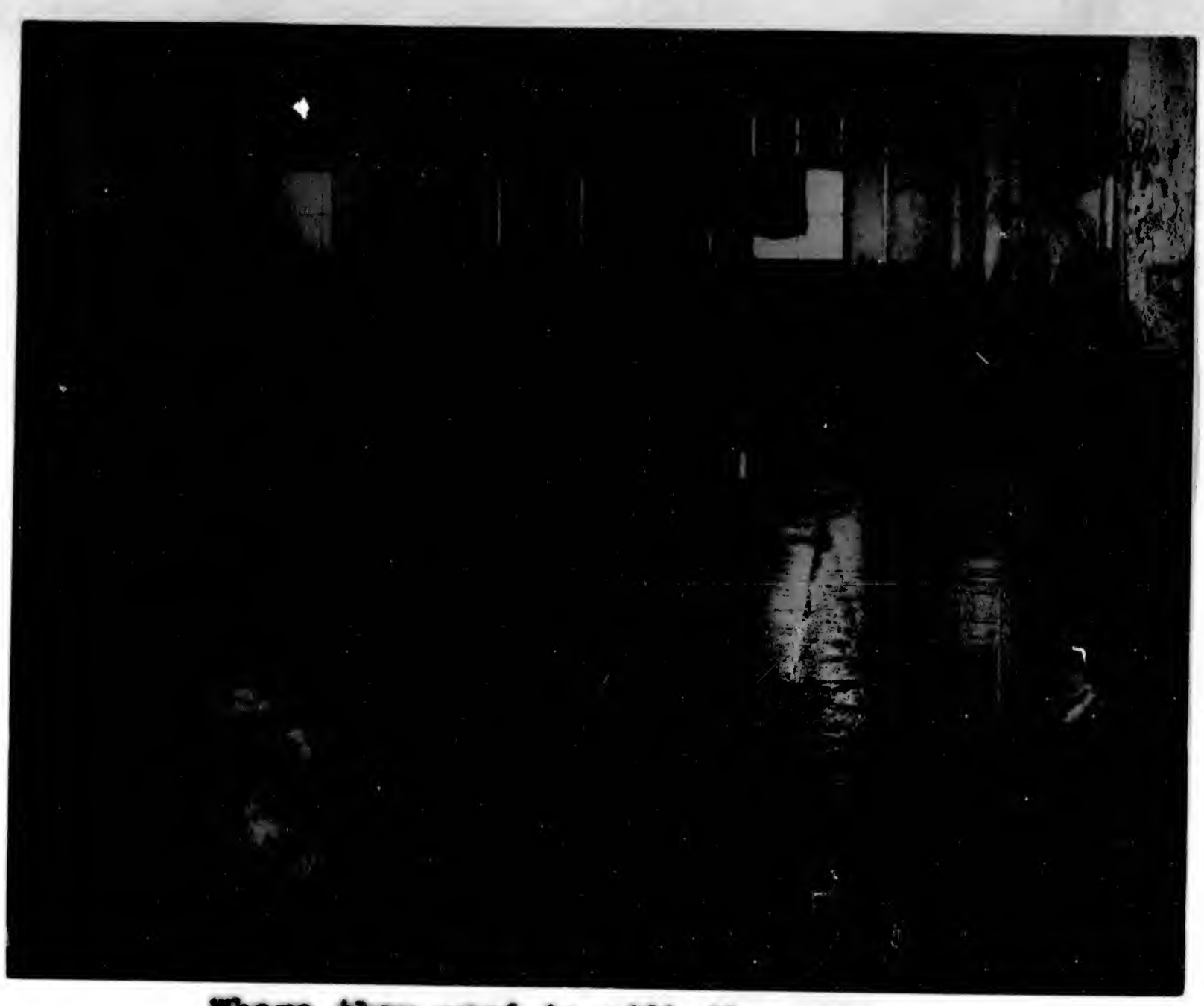
(b) Bucket washed bacteriologically clean.
Washed with hot water and alkali powder and steamed ten minutes.

this country it is also very common. It is apt to run through a whole herd after it once gets a foothold. The disease is frequently introduced into a herd by the purchase of stock that appears to be healthy but is really infected with the disease."

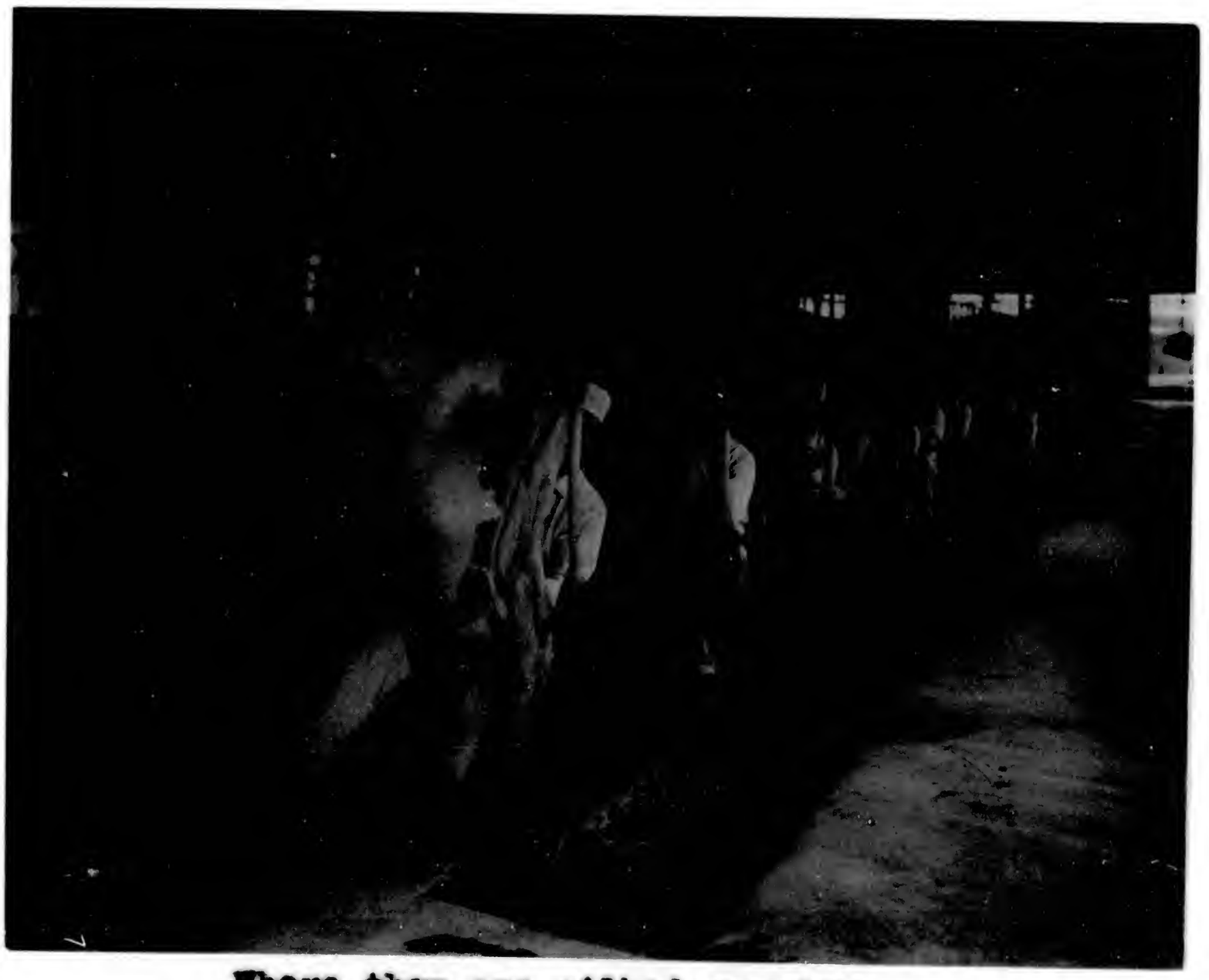
Statistics have also shown that the disease has been rapidly increasing among cattle in the last twenty-five years and is now perhaps the most serious problem that the dairyman has to face and one that threatens to undermine the whole industry. The only way that a dairyman can be sure that no dangerous tuberculous milk is furnished to his patrons, is to have all his herd properly tested with tuberculin and so treated as to be sure that none of them are suffering from the disease.

Care and Feeding.

In contrast to the care given dairy cattle in the preceding century, when cows were given little or no protection from storms in the winter and were fed almost exclusively on overripe swale grass cut from the marshes, we now have the modern dairy barn where the greatest care and attention are exercised in providing comfortable quarters for the animals. The floors, stalls and feed boxes are arranged for daily scrubbing and kept immaculately clean. The barn is so constructed and arranged that the ventilation is as nearly perfect as it is possible to make it. Feeding is conducted on a scientific basis, so that, the cow receives a well balanced ration in the proper proportions to produce the most liberal flow of milk. The study by German scientists of the principles underlying nutrition of farm animals during the middle part of the last century, have crystallized in what are known as "Feeding Standards". These



Where they used to milk the cows.



Where they are milked nowadays.

standards show the total quanity of dry matter and digestible food components required daily by animals under different conditions as to age, weight and production. The standards proposed by the German investigator, Emil V. Wolff, have become very well known in this country and are referred to as the "German Feeding Standards". This standard provided for 24.5 pounds of total dry matter in the daily feed of a dairy cow and for a content of 25 pounds of digestible protein, 12.5 pounds of digestible carbo-hydrates and .4 pound of digestible fat, the nutritive ratio being 1 part protein to 5.4 parts carbo-hydrates and fat. During the last dozen years evidence, furnished by careful investigations and practical experience, has demonstrated that the exact nutritive ratio of a ration, or the amount of digstible protein it contains, is not a matter of such great importance as it was formerly thought to be, provided, the cow receives sufficient total digestible matter and a minimum amount of protein. The nutritive ratio may vary from 1 ; 5 to 1 : 9 without greatly influencing the quanity or quality of the production, the narrower ratio, however, being generally more conducive to good results. Among American investigators the concensus of opinion seems to indicate that a good dairy cow in full flow of milk should receive about 25 pounds of dry matter, 15 to 18 pounds of digestible matter and, at least, 2 pounds of digestible protein.

THE SILO. The preservation of forage in a succulent condition is another of the advancements in the dairy industry during the last half century. *"The history of silage dates back to antiquity, but it was not until 1875 that it attracted much attention or

*Bul.129, Md. Agrl. Expt. Sta.

can be said to have been introduced into modern agriculture. In 1875, Auguste Goffart,of France, announced the results of his experiments, covering several years, with the preservation of green forage. The first silage made in America was put up by Francis Morris, of Maryland, in 1876, by putting whole corn in a trench or pit dug in the ground and then covered with earth. The first silo in America was built by Dr. J. M. Bailey of Boston, Massachusetts, the successful opening of which was reported in "The Country Gentleman" in December, 1879. This report, together with Dr. Bailey's "Book of Ensilage" published in 1880, brought the subject of silos and silage prominently before the farmers of the United States and resulted in many adopting this method of preserving feed and becoming enthusiastic advocates of the practice. From this beginning the use of the silo has spread rapidly until to-day there are few dairy sections where silos are not common and in general use."

Cow Testing Associations.

Gratifying improvements in the dairy industry are taking place in the rural districts through the agency of "Cow Testing Associations". This is a recent step in dairy progress, the first association in this country having been organized in Newaygo County, Michigan, in 1905. The plan is practically this: fifteen or twenty dairymen form an association and pay one dollar for each cow per year to help pay the expenses of the test. They hire a competent person to do the work, board and lodge the official tester while at their farm one day in each month, buy all the necessary apparatus, make all arrangements to have the work carried on accurately and

systematically, and then convey the tester to the next farm, which should not be more than two miles distant. The tester visits each farm regularly, weighs and tests the milk from each cow, assists each dairyman to figure out proper rations and makes such suggestions as he believes will prove helpful. At the end of the year the dairyman has a reasonably accurate record of every cow in his herd. He knows what it cost to keep them and he can easily discard the unprofitable animals.

By-Products of the Dairy.

The last few years have shown a rapid development in the utilization of the by-products of the dairy. Fifteen years ago at creameries and cheese factories large quanities of skim milk and whey were absolutely wasted. On farms these products were utilized for feeding, but in the large factories such a course was impracticable. New branches have lately been added to the industry and now there are many plants which extract the sugar from the milk and whey, and also manufacture other commercial products from the same materials. Albumen is extracted for use with food products and in the arts. Lacto and Milk flakes are manufactured for human food. Casein is dessicated and prepared as a baking supply and substitute for eggs, as the basis of an enamel paint, as a fixer of the colors in calico prints, as a substitute for glue in sizing paper and is also solidified and used for the manufacture of dominos, buttons, combs, brush backs, handles, cigar holders, electrical insulators and similar articles.

Number of Cows and Quanity and Value of Dairy Products.

The following tables from Bulletin 55, Bureau Animal Industry will show at a glance the wonderful progress of the dairy industry in the United States during the last fifty years.

Progress of Dairying in United States, 1850 to 1900 (a)

...r ... ...gus	Dairy Cows on Farms. Total Number	Dairy Cows on Farms. Per 1000 Persons	Milk Product Reported.	Butter Total Made.	Cheese Total Made.	Creameries and Cheese Factories	Milk Average Yield per Cow
...00	17,139,674	225	Gallons 7,266,392,674	Pounds 1,491,871,673	Pounds 298,344,654	Number 9,355	Gallons 424
...80	16,511,950	264	5,209,125,567	1,205,508,384	256,761,883	4,712	315
...60	12,443,120	248	(b)530,129,755	806,672,071	243,157,850	3,932	233
...70	8,935,332	232	(c)235,500,599	514,092,683	162,927,382	(d) 1,313	206
...50	8,585,735	273	Not given	459,681,372	103,663,927	(d) 5	175
...50	6,385,094	275	Not given	313,345,306	105,535,893	(d) 8	167

(a) Does not include product of cows in barns and inclosures.

(b) Milk sold or sent to butter and cheese factories.

(c) Milk sold from farms.

(d) Cheese factories only.

If we include with the foregoing the estimated product from 973,033 cows not on farms and ranges, also the butter and cheese made at urban establishments, the figures for 1900 are as follows;-

Total Number of Cows and Dairy Products for 1900.

Year of Census	Dairy Cows in United States: Total Number	Dairy Cows in United States: Per 1000 Persons	Milk Product Reported plus estimated milk (Gallons)	Total Butter made (Pounds)	Total Cheese made (Pounds)
1900	18,112,707	237	7,728,583,349	1,492,699,143	299,006,818

TIGHT BINDING TEXT CUT OFF

If we assign two cents per quart as the value of milk consumed as human food and one-and-three-fourth cents per quart for the whole milk fed to calves or similarly used on farms, we find the aggregate value of the dairy products of the United States for 1900 to be as follows:

Value of Dairy Products, 1900.

Butter	$263,256,852
Cheese	28,060,362
Condensed Milk	11,888,792
Cream Sold	4,547,536
Milk Consumed	217,512,586
Milk Fed to Calves	39,000,000
By-Products	41,049,226
Total	605,315,354

To this aggregate should be added the value of calves dropped by dairy cows during the year. There were doubtless nearly 18,000,000 calves which were fairly rated at one dollar each at time of birth. The great aggregate production of dairy cows of the United States may,therefore, be placed at $620,000,000 to $625,000,000 per year.

In conclusion we may say that dairying has become a specialty in districts of wide area throughout the United States and is now regarded as one of the most progressive and highly developed types of farming. No other industry has profited more by the inventive genius of man, the applications of modern science, and the intelligent practice of skilled operators,nor

has any other made greater improvement during the evolution of agriculture in the United States.

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